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Search Results -

Terms	Documents
(L1 or L2) and (estimat$3 adj external aadj interaction)	307

Database:
US Pre-Grant Publication Full-Text Database
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Search History

DATE: Thursday, January 08, 2004 Printable Copy Create Case

Set Name side by side	**Query**	**Hit Count**	**Set Name** result set
	DB=PGPB,USPT,USOC,EPAB,JPAB,DWPI,TDBD; PLUR=NO; OP=OR		
L17	(l1 or l2) and (estimat$3 adj external aadj interaction)	307	L17
L16	(l1 or l2) and (estimat$3 adj3 external aadj interaction)	308	L16
L15	(l1 or l2) and (estimat$3 adj3 external aadj3 interaction)	308	L15
L14	(l1 or l2) and (variable adj intrinsic)	0	L14
L13	(l1 or l2) and (estimat$3 same synchroniz$5)	3	L13
L12	(l1 or l2) and (estimat$3 adj5 synchroniz$5)	0	L12
L11	(l1 or l2) and (resynchroniz$5)	2	L11
L10	(l1 or l2) and (estimat$3 adj5 resynchroniz$5)	1	L10
L9	L6 and (control$4 adj system)	11	L9
L8	L6 and (control$4 adj system)	11	L8
L7	L6 and (force adj feedback)	2	L7
L6	(phantom adj model)	80	L6
L5	(l1 or l2) and (phantom adj model)	2	L5
L4	(l1 or l2) and (phantom adj model adj5 estimat$3)	1	L4

L3	(l1 or l2) and (remote$2 adj3 interact$3)	14	L3
L2	(force adj feedback) and (control$4 adj system)	911	L2
L1	(5956484 or 6101530 or 6161126 or 6125385).pn.	6	L1

END OF SEARCH HISTORY

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L13: Entry 3 of 3 File: USPT May 15, 1990

DOCUMENT-IDENTIFIER: US 4925312 A
TITLE: Robot control system having adaptive feedforward torque control for improved accuracy

Brief Summary Text (6):
U.S. Pat. No. 4,763,055 entitled DIGITAL ROBOT CONTROL HAVING HIGH PERFORMANCE SERVO CONTROL SYSTEM and filed by Kenneth E. Daggett, Richard J. Casler and Eimei Onaga.

Brief Summary Text (7):
Ser. No. 932,974, now continuation Ser. No. 178,813, filed Apr. 1, 1988, entitled DIGITAL ROBOT CONTROL SYSTEM PROVIDING PULSE WIDTH MODULATION FOR A BRUSHLESS DC DRIVE and filed by K. E. Daggett, R. A. Johnson, E. M. Onaga and R. J. Casler.

Brief Summary Text (11):
U.S. Pat. No. 4,786,847 entitled DIGITAL ROBOT CONTROL SYSTEM PROVIDING IMPROVED ROBOT PERFORMANCE WITH COST EFFECTIVENESS AND CONTROL UNIT MANUFACTURING ECONOMY and filed by K. E. Daggett, E. M. Onaga, R. J. Casler, Jr., B. L. Booth, R. J. Penkar et al., L. C. Vercellotti and R. A. Johnson.

Brief Summary Text (12):
Ser. No. 932,983 entitled MODULAR ROBOT CONTROL SYSTEM and filed by K. E. Daggett, E. M. Onaga, B. L. Booth, R. J. Casler, Jr. and V. P. Jalbert.

Brief Summary Text (13):
Ser. No. 932,977, now continuation Ser. No. 180,601, filed Apr. 6, 1988, entitled MULTIPROCESSOR TORQUE SERVO CONTROL FOR MULTIAXIS DIGITAL ROBOT CONTROL SYSTEM and filed by K. E. Daggett, E. M. Onaga and R. J. Casler, Jr.

Brief Summary Text (14):
Ser. No. 932,990, now continuation Ser. No. 180,723, filed Apr. 4, 1988, entitled MULTIPROCESSOR POSITION/VELOCITY SERVO CONTROL FOR MULTIAXIS DIGITAL ROBOT CONTROL SYSTEM and filed by R. E. Lancraft, K. E. Daggett, E. M. Onaga, R. J. Casler, Jr., B. L. Booth, N. J. Bergman and M. D. Muncy.

Brief Summary Text (25):
In the prior art, position inaccuracy due to lag in torque development has been reduced to some extent by employing in each joint control a feedforward torque signal derived from the command acceleration and an inertia constant for the associated link. This type of feedforward control has been employed for example in the digital robot control system exemplary of the type disclosed in U.S. Pat. Nos. 4,763,055 and 4,786,847, which are assigned to the same assignee as the presently assigned invention.

Drawing Description Text (7):
FIGS. 6A-1 and 6A-2 show a schematic diagram of a first electronic torque processor (TP) board employed as a basic torque servo control for the robot control system;

Detailed Description Text (2):
As shown in its preferred form in FIG. 1, a robot control system 10 is arranged to include adaptive feedforward torque control that provides improved robot operation in accordance with the invention. A control arrangement like that shown is used for each robot axis and all axis controls are operated in coordination to produce the commanded motion for the robot end effector.

Detailed Description Text (14):
Feedforward torque commands are computed in generator block 130 and implemented in control loop operation to provide more accurate robot motion over commanded paths. An algorithm in the feedforward torque command generator block 130 employs dynamic and kinematic data and operates on inputs derived in block 129 from position commands 128 and wrist force feedback from sensor 132 to generate the feedforward torque commands.

Detailed Description Text (32):
The basic torque processor (TP) board 600 provides a functional interface to the robot joint drive motors. Functionally, the basic TP board 600 implements the lowest level of control in the hierarchical control system, providing closed loop servo torque control for six robot axes. Physically, the basic TP board 600 electrically interfaces the robot path planning control system and the servo control (SCM) board with the arm interface (AIF) board 800, which in turn interfaces to the robot joint drive motors. The primary function of the basic TP board 600 is to regulate robot joint motor currents to commanded values by generating motor winding voltage commands which are executed using a pulse width modulation scheme on the AIF board.

Detailed Description Text (132):
A variable `NUMJNT` specifies the total number of joints of the manipulator. Both the forward recursion and the backward recursion loop n times for an n joint manipulator to calculate a set of joint torques. After the start of the program 670F, the operation stops at box 673F and waits for the TM manager 602A to activate the torque estimator 610A. The BIO pin of the TMS320 processor is properly connected to the 68000 processor so that when the 68000 processor puts the BIO pin in the active state (active low), the Newton-Euler algorithm in the program 670F is activated. After the completion of calculating the dynamic feedforward, the TMS320 notifies the 68000 that the operation is done and the BIO pin is held high by the 68000 so that the TMS320 stops processing. The TMS320 thus is put into a wait space until the 68000 activates it again to start another cycle of torque calculations. Operation of the two processors is thus synchronized.

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L13: Entry 2 of 3 File: USPT Aug 19, 1997

DOCUMENT-IDENTIFIER: US 5659480 A
TITLE: Method for coordinating motion control of a multiple axis machine

Brief Summary Text (8):
If the slave controllers are modeled properly and tuned for similar closed-loop Eigenvalues, then synchronization will occur. However, if there are errors in the feedforward estimates or disturbances acting on one or more slave axes, the coordination of the machine suffers. Furthermore,.if a prescribed trajectory is infeasible, the system may enter the highly non-linear realm of saturation. These situations have many undesirable properties. Thus, present control topologies for computer controlled, servo-driven multiple axis machines emulating dynamically variable kinematics have not been able to replicate the beneficial inter-axis stiffness provided by line shaft machines.

Brief Summary Text (10):
A general object of the present invention is to provide a virtual common shaft control system for operating a multiple axis machine with dynamically variable kinematics.

Brief Summary Text (11):
Another object is to provide relative stiffness among independent axes which are connected via dynamically variable kinematic relationships and act collectively as a one input command-driven coordinated motion control system.

Brief Summary Text (13):
Although the machine actually has separately powered actuators, such as servo-motors that drive each axis, the machine operates as though the axes are driven from a common line shaft. By controlling the actuators with signals derived from the simulation of the virtual line shaft and virtual dynamically variable kinematic mechanical linkages, movement along or about a given axis is dependent upon the operation of the entire machine. Thus the present electronic control system provides the dynamically variable mechanical cross coupling of the axes found in mechanical cam driven, interconnected axes machines. As a consequence, if any combination of axes encounters either load resistance or is driven by the load, movement along or about the other axes are affected by that resistance such that synchronization of all axes is maintained.

Drawing Description Text (4):
FIG. 3 is a schematic block diagram of the electronic control system for the multiple axis machine;

Drawing Description Text (5):
FIG. 4 is a block diagram of a four-axis virtual line shaft control system which is implemented by software in the computer of the machine; and

Drawing Description Text (6):
FIG. 5 is a functional block diagram of the control technique for each axis of the control system shown in FIG. 4.

Detailed Description Text (5):

The electronic control system 50 for operating the filament winding machine 10 is shown in FIG. 3. The control system 50 is built around a microcomputer 52 which includes input/output circuits, one or more central processing units, a random access memory 54 and a read only memory 56. The microcomputer 52 is also connected to an external memory 58 that provides additional storage for the control program of the filament winding machine. The control panel 48 is connected to the microcomputer by a control panel interface circuit 60.

Detailed Description Text (12):
FIG. 4 is a functional block diagram of the virtual line shaft control system which is simulated by the microcomputer 52 to produce torque command signals for the servo-motors 25, 26, 32 and 44. Block 100 represents the functional equivalent of a line shaft which is used to simulate a virtual line shaft in the control system 50. Specifically, the input angular velocity .omega..sub.V, emulates the no-load line shaft speed. This angular velocity is summed with a feedback signal in summer 102 with the result being applied to function block 104 where the resultant value is multiplied by a variable b.sub.av corresponding to the viscous friction or viscous damping gain of the line shaft. The product from function block 104 is applied to a second summer 106 where a feedback torque value designated T.sub.sfbr2, is subtracted from the product. The resultant value is applied to function block 108 where the input is divided by quantity J.sub.V which represents the inertia of the virtual line shaft. The output of function block 108 is a numerical value corresponding to the angular acceleration .omega..sub.V of the virtual line shaft 100. The angular acceleration is integrated at step 110 to produce the angular velocity .omega..sub.V which is fed back as the negative input of the first summer 102. The value corresponding to the angular velocity .omega..sub.V is applied to a second integrator 112 to produce a value of the angular position .theta..sub.V of the virtual line shaft 100. The viscous friction or viscous damping gain b.sub.av and inertia J.sub.V are characteristics of the virtual line shaft that are analogous to the physical mechanical line shaft characteristics when driven by conventional prime movers. The angular acceleration, velocity and position of the line shaft, along with the command vector variables of position .theta..sub.n, velocity .omega..sub.n and acceleration .omega..sub.n for each axis n, are collectively referred to as the "command vector variable states."

CLAIMS:

1. A method for controlling a machine which has members that move with respect to first and second axes wherein movement with respect to each axis is produced by a separately powered actuator controlled by a computer and wherein movement along each axis is controlled in response to motion along another axis, said method comprising:

sensing a first position of machine movement with respect to the first axis;

determining a first velocity of machine movement with respect to the first axis;

sensing a second position of machine movement with respect to the second axis;

determining a second velocity of machine movement with respect to the second axis;

simulating on the computer a virtual line shaft which has variable states of shaft acceleration, shaft velocity and shaft position, wherein said simulating includes a virtual replication of relative stiffness of a mechanical line shaft;

simulating on the computer a virtual first mechanical linkage with dynamically variable kinematics which responds to the shaft acceleration, shaft velocity, shaft position, the first position and the first velocity, wherein simulating the virtual first mechanical linkage produces a first control signal for operating a first actuator of the machine and produces a first dynamically variable kinematic force

feedback signal;

simulating on the computer a virtual second mechanical linkage with dynamically variable kinematics which responds to the shaft acceleration, shaft velocity and shaft position, the second position and the second velocity, wherein simulating the virtual second mechanical linkage produces a second control signal for operating a second actuator of the machine and produces a second dynamically variable kinematic force feedback signal;

operating the first actuator in response to the first control signal; and

operating the second actuator in response to the second control signal;

wherein the step of simulating a virtual line shaft is responsive to the first and second dynamically variable kinematic force feedback signals.

2. A method for controlling a machine having members that move with respect to first and second axes wherein movement with respect to each axis is produced by a separately powered actuator controlled by a computer and wherein movement along each axis is controlled in response to motion along another axis, said method comprising steps of:

defining characteristics of a line shaft for powering the machine;

defining characteristics of a first mechanical linkage with dynamically variable kinematics that is driven by the line shaft to produce movement with respect to the first axis;

defining characteristics of a second mechanical linkage with dynamically variable kinematics that is driven by the line shaft to produce movement with respect to the second axis;

simulating a virtual line shaft on the computer using the characteristics of a mechanical line shaft including a virtual replication of relative stiffness, wherein the simulating produces an angular position value of the virtual line shaft, an angular velocity value of the virtual line shaft and an angular acceleration value of the virtual line shaft;

simulating a virtual first mechanical linkage on the computer using the characteristics of a first mechanical linkage, the angular velocity value of the virtual line shaft, the angular position value of the virtual line shaft, a first position .theta..sub.1 of machine movement with respect to the first axis, a first velocity .omega..sub.1 of machine movement with respect to the first axis, wherein simulating the virtual first mechanical linkage produces a first control signal for operating a first actuator of the machine and produces a first force feedback signal representing force applied by the virtual first mechanical linkage to the virtual line shaft;

operating the first actuator in response to the first control signal;

simulating a virtual second mechanical linkage on the computer using the characteristics of a second mechanical linkage, the angular velocity value of the virtual line shaft, the angular position value of the virtual line shaft, a second position .theta..sub.2 of machine movement with respect to the second axis, a second velocity .omega..sub.2 of machine movement with respect to the second axis, wherein simulating the virtual second mechanical linkage produces a second control signal for operating a second actuator of the machine and produces a second force feedback signal representing force applied by the virtual second mechanical linkage to the virtual line shaft; and

operating the second first actuator in response to the second control signal;

wherein the step of simulating a virtual line shaft also is responsive to the first and second force feedback signals.

13. The method as recited in claim 2 wherein simulating the virtual first mechanical linkage further comprises:

deriving a linkage velocity value .omega..sub.1 * as a function of the angular velocity value of the virtual line shaft, the angular position value of the virtual line shaft, and the characteristics of the first mechanical linkage;

determining a velocity error value .omega..sub.err.sbsb.1 from a difference between the linkage velocity value .omega..sub.1 * and the first velocity .omega..sub.1 ;

deriving a force feedback value by applying a value corresponding to an active damping gain b.sub.r2.sbsb.1 of the first axis to the velocity error value .omega..sub.err.sbsb.1 ; and

producing the first force feedback signal from the force feedback value.

14. The method as recited in claim 2 wherein simulating the virtual first mechanical linkage further comprises:

deriving a linkage position value .theta..sub.1 * as a function of the angular velocity value of the virtual line shaft, the angular position value of the virtual line shaft and the characteristics of the first mechanical linkage;

determining a position error value .theta..sub.err.sbsb.1 from a difference between the linkage position value .theta..sub.1 * and the first position .theta..sub.1 ;

producing the first force feedback signal by applying an active stiffness gain K.sub.sr2.sbsb.1 value for the first mechanical linkage to the position error value .theta..sub.err.sbsb.1.

15. The method as recited in claim 2 wherein simulating the virtual first mechanical linkage further comprises:

deriving a linkage velocity value .omega..sub.1 * as a function of the angular velocity value of the virtual line shaft, the angular position value of the virtual line shaft, and the characteristics of the first mechanical linkage;

determining a velocity error value .omega..sub.err.sbsb.1 from a difference between the linkage velocity value .omega..sub.1 * and the first velocity .omega..sub.1 ;

deriving a first intermediate signal by applying a value corresponding to an active damping gain b.sub.r2.sbsb.1 of the first axis to the velocity error value .omega..sub.err.sbsb.1 ;

deriving a linkage position value .theta..sub.1 * as a function of the angular position value of the virtual line shaft and the characteristics of the first mechanical linkage;

determining a position error value .theta..sub.err.sbsb.1 from a difference between the linkage position value .theta..sub.1 * and the first position .theta..sub.1 ;

deriving a second intermediate signal by applying a value corresponding to an active stiffness gain K.sub.sr2.sbsb.1 of the first mechanical linkage to the position error value .theta..sub.err.sbsb.1 ; and

producing the first force feedback signal from the first and second intermediate signals.

16. The method as recited in claim 2 wherein simulating the virtual first mechanical linkage further comprises:

deriving a linkage position value .theta..sub.1 * as a function of the angular position value of the virtual line shaft and the characteristics of the first mechanical linkage;

determining a position error value .theta..sub.err.sbsb.1 from a difference between the linkage position value .theta..sub.1 * and the first position .theta..sub.1 ;

integrating the position error value .theta..sub.err.sbsb.1 to produce an integrated error value; and

producing the first force feedback signal by applying a value corresponding to an active integrated stiffness gain K.sub.isr2.sbsb.1 of the first mechanical linkage to the integrated error value.

17. The method as recited in claim 2 wherein simulating the virtual first mechanical linkage further comprises:

deriving a linkage velocity value .omega..sub.1 * as a function of the angular velocity value of the virtual line shaft, the angular position value of the virtual line shaft, and the characteristics of the first mechanical linkage;

determining a velocity error value .omega..sub.err.sbsb.1 from a difference between the linkage velocity value .omega..sub.1 * and the first velocity .omega..sub.1 ;

deriving a first intermediate signal by applying a value corresponding to an active damping gain b.sub.r2.sbsb.1 of the first axis to the velocity error value .omega..sub.err.sbsb.1 ;

deriving a linkage position value .theta..sub.1 * as a function of the angular position value of the virtual line shaft and the characteristics of the first mechanical linkage;

determining a position error value .theta..sub.err.sbsb.1 from a difference between the linkage position value .theta..sub.1 * and the first position .theta..sub.1 ;

deriving a second intermediate signal by applying a value corresponding to an active stiffness gain K.sub.sr2.sbsb.1 of the first mechanical linkage to the position error value .theta..sub.err.sbsb.1 ; and

integrating the position error value .theta..sub.err.sbsb.1 to produce an integrated error value; and

deriving a third intermediate signal by applying a value corresponding to an active integrated stiffness gain K.sub.isr2.sbsb.1 of the first mechanical linkage to the integrated error value;

combining the first intermediate signal, the second intermediate signal and the third intermediate signal to produce a force feedback value T.sub.sfbr2.sbsb.1 ; and

producing the first force feedback signal from the force feedback value.

18. The method as recited in claim 17 wherein the step of producing the first force feedback signal is in response to the force value and the characteristics of the

first mechanical linkage, so that the first force feedback signal becomes a dynamically variable kinematic force feedback signal.

19. The method as recited in claim 2 wherein the step of producing the first force feedback signal also is responsive to the characteristics of the first mechanical linkage, so that the first force feedback signal becomes a dynamically variable kinematic force feedback signal.

20. A method for controlling a machine which has members that move with respect to a plurality of n axes where n is a plural positive integer, and wherein movement along and about each axis is produced by a separately powered actuator controlled by a computer and wherein movement along and about each axis is controlled in response to motion with respect to other axes, said method comprising steps of:

(a) defining characteristics of a line shaft for powering the machine;

(b) for each one of the plurality of n axes defining characteristics of a separate mechanical linkage with dynamically variable kinematics that is driven by the line shaft to produce movement along one axis;

(c) simulating on the computer a virtual line shaft using the characteristics of the line shaft including a virtual replication of relative stiffness, wherein the simulating produces an angular acceleration value of the virtual line shaft, an angular velocity value of the virtual line shaft and an angular position value of the virtual line shaft;

(d) simulating on the computer a separate virtual mechanical linkage with dynamically variable kinematics for each one of the plurality of n axes using characteristics defined in step (b), an angular acceleration value of the virtual line shaft, the angular velocity value of the virtual line shaft, the angular position value of the virtual line shaft, a first position of machine movement with respect to one of the plurality of n axes, a first velocity of machine movement with respect one of the plurality of n axes, wherein the simulating of each virtual mechanical linkage produces a control signal for operating a servo-motor for an axis of the machine and produces a dynamically variable kinematic feedback force signal; and

(e) controlling the servo-motors for each axis with control signals produced by step (d);

wherein the step of simulating a virtual line shaft also is responsive to dynamically variable kinematic force feedback signals produced by step (d).

22. The method as recited in claim 20 wherein said step of simulating on the computer a separate virtual mechanical linkage for each one of the plurality of n axes comprises:

for each axis determining an axis position .theta..sub.n and axis velocity .omega..sub.n of machine movement with respect to an axis, where n is a number denoting a particular axis;

deriving a linkage position value .theta..sub.n * for each axis as a function of the angular position value of the virtual line shaft and the characteristics of the mechanical linkage for each axis;

deriving a linkage velocity value .omega..sub.n * as a function of the angular velocity value of the virtual line shaft, the angular position value of the virtual line shaft, and the characteristics of the first mechanical linkage; and

determining a velocity error value .omega..sub.err.sbsb.n for each axis from a

difference between the linkage velocity value .omega.*.sub.n and a velocity .omega..sub.n for each axis;

deriving a first intermediate value for each axis by applying a value corresponding to an active damping gain b.sub.r2.sbsb.n for each axis to the velocity error value .omega..sub.err.sbsb.n for each axis;

determining a position error value .theta..sub.err.sbsb.n for each axis from a difference between the linkage position value .theta..sub.n * and a position .theta..sub.n of each axis;

deriving a second intermediate value for each axis by applying a value corresponding to an active stiffness gain K.sub.sr2.sbsb.n of the mechanical linkage for each axis to the position error value .theta..sub.err.sbsb.n for each axis;

integrating the position error value .theta..sub.err.sbsb.n for each axis to produce an integrated error value for each axis;

deriving a third intermediate value for each axis by applying a value corresponding to an active integrated stiffness gain K.sub.isr2.sbsb.n for each axis to the integrated error value for each axis; and

for each axis combining the first intermediate value, the second intermediate value and the third intermediate value to produce a force value T.sub.sfbr2.sbsb.n for each axis from which the dynamically variable kinematic force feedback signal is produced.

First Hit

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L13: Entry 1 of 3 File: PGPB Feb 6, 2003

DOCUMENT-IDENTIFIER: US 20030027684 A1
TITLE: Apparatus for controlling vehicle drive system including drive power source and automatic transmission

Abstract Paragraph:
Apparatus for controlling a vehicle drive system including an automatic transmission, including a feedback controller operable upon a shift-down action of the transmission effected by concurrent releasing and engaging actions of first and second frictional coupling devices during an operation of a manually operable vehicle accelerating member to drive the vehicle with the drive power soruce, for controlling an engaging force of the first frictional coupling device, and a learning compensator operable upon detection of an abnormality of the shift-down action, for learning compensation of an initial value of the engaging force at which a feedback control of the engaging force is initiated, or an output reducing device for reducing an output of a drive power source when input speed of the transmission has been increased to a value close to a synchronization value, and/or upon racing of the drive power source during the shift-down action.

Summary of Invention Paragraph:
[0005] In an automotive vehicle, there is widely used an automotive transmission having a plurality of forward drive positions which have respective different speed ratios and which are selectively established by respective combinations of engaging and releasing actions of a plurality of frictional coupling devices. An automatic transmission of this type is automatically shifted up and down on the basis of suitably selected parameters such as an operating amount of an accelerator pedal and a running speed of the vehicle, and according to a predetermined relationship between a running condition of the vehicle defined by the selected parameters and the operating position to which the automatic transmission should be shifted. The predetermined relationship may be represented by a stored shift-boundary data map, as indicated in the graph of FIG. 6 by way of example. It will be understood from shift-down boundary lines indicated by broken lines in FIG. 6 that the automatic transmission is shifted down to increase the sped ratio when the vehicle running speed V is lowered or when an opening angle .theta..sub.TH of a throttle valve (corresponding to the operating amount of the accelerator pedal) is increased. The speed ratio is a ratio of an input speed to an output speed of the automatic transmission. Some of the forward drive positions are established by concurrent engaging and releasing actions of respective two frictional coupling devices, namely, an engaging action of a first frictional coupling device and a releasing action of a second frictional coupling device, which take place concurrently with each other. When the automatic transmission is shifted by such concurrent engaging and releasing actions of the two frictional coupling devices, there may arise abnormal shifting behaviors of the frictional coupling devices, which cause a racing of a drive power source such as an engine, and a so-called "tie-up" behavior which causes a delayed shifting action of the automatic transmission to the selected forward drive position. The racing of the drive power source takes place when the first frictional coupling device to be released is prematurely brought to a substantially released state while the second frictional coupling device to be engaged is still in a substantially fully released state. On the other hand, the tie-up behavior takes place when the second frictional coupling device is prematurely brought to a substantially engaged state while the first frictional

coupling device is still in a substantially fully engaged state. Therefore, the concurrent engaging and releasing actions of the two frictional coupling devices must be intricately controlled. JP-A-8-145157 discloses an example of controlling concurrent engaging and releasing actions of the two frictional coupling devices to effect a shift-up action of the automatic transmission to reduce the speed ratio, such that the engaging force of the second frictional coupling device to be engaged is controlled in a feedback fashion, and such that the engaging force at which the feedback control is initiated is updated by a learning compensation technique.

Summary of Invention Paragraph:
[0008] The object indicated above may be achieved according to one aspect of this invention, which provides an apparatus for controlling a drive system of an automotive vehicle including a manually operable vehicle accelerating member, a drive power source, and an automatic transmission having a plurality of forward drive positions which have respective different speed ratios and which are selectively established by respective combinations of engaging and releasing actions of a plurality of frictional coupling devices, the apparatus comprising feedback control means operable upon a shift-down action of the automatic transmission which is effected by concurrent releasing and engaging actions of respective first and second frictional coupling devices of the plurality of frictional coupling devices, during an operation of the vehicle accelerating member to drive the automotive vehicle with the drive power source, the feedback control means feedback-controlling an engaging force of the first frictional coupling device, the apparatus being characterized by further comprising: shifting-abnormality detecting means for detecting one of a racing of the drive power source and a tie-up behavior of the first and second frictional coupling devices during the shift-down action of the automatic transmission; and learning compensation means operable upon detection of the above-indicated one of the racing and the tie-up behavior by the shifting-abnormality detecting means, for effecting learning compensation of an initial value of the engaging force of the first frictional coupling device at which a feedback control of the engaging force by the feedback control means is initiated.

Summary of Invention Paragraph:
[0021] According to a second preferred form of the second aspect of the invention, the pre-synchronization output reducing means reduces the output of the drive power source, by retarding an ignition timing of the drive power source. This form of the apparatus is effective to improve the control response, particularly where the drive power source is an internal combustion engine such as a gasoline engine. The method of reducing the output of the drive power source is desirably determined by the specific type of the drive power source. In one advantageous arrangement of the above preferred form of the second aspect of the invention, the pre-synchronization output reducing means retards the ignition timing on the basis of a running speed of the vehicle and an estimated input torque of the automatic transmission, and according to a predetermined data map or equation. In this case, the ignition timing can be intricately controlled. However, the pre-synchronization output reducing means may be arranged to reduce the output of the drive power source or retard the ignition timing, by a predetermined constant amount. The pre-synchronization output reducing means may start the reduction of the output of the drive power source, immediately after the moment of a determination by the substantial synchronization determining means that the input speed of the automatic transmission has been increased to the threshold value close to the synchronization speed. Alternatively, the pre-synchronization output reducing means starts the reduction of the output of the drive power source, a predetermined delay time after the moment of the determination by the substantial synchronization determining means. The delay time may be determined depending upon the specific manner of the determination by the substantial synchronization determining means.

Summary of Invention Paragraph:
[0022] According to a second preferred form of the second aspect of the invention,

the vehicle drive system control apparatus further comprises: racing-abnormality detecting means for detecting a racing of the drive power source during the shift-down action of the automatic transmission during the operation of the vehicle accelerating member; and racing-abnormality output reducing means operable upon detection of the racing by the racing-abnormality detecting means, for immediately reducing an output of the drive power source. According to a third preferred form of the second aspect of the invention, the vehicle drive system control apparatus further comprises: shifting-abnormality detecting means for detecting one of a racing of the drive power source and a tie-up behavior of the first and second frictional coupling devices during the shift-down action of the automatic transmission; and learning compensation means operable upon detection of the racing or the tie-up behavior by the shifting-abnormality detecting means, for effecting learning compensation of an initial value of the engaging force of the first frictional coupling device at which a feedback control of the engaging force by the feedback control means is initiated.

Summary of Invention Paragraph:
[0028] According to a third preferred form of the third aspect of the invention, the apparatus further comprises: shifting-abnormality detecting means for detecting one of a racing of the drive power source and a tie-up behavior of the first and second frictional coupling devices during the shift-down action of said automatic transmission; and learning compensation means operable upon detection of the racing of the drive power source or the tie-up behavior of the shifting-abnormality detecting means, for effecting learning compensation of an initial value of the engaging force of the first frictional coupling device at which a feedback control of the engaging force by the feedback control means is initiated.

Brief Description of Drawings Paragraph:
[0032] FIG. 3 is a block diagram showing a control system incorporating the control apparatus according to one embodiment of this invention for controlling an engine and the automatic transmission of the vehicle drive system of FIG. 1;

Brief Description of Drawings Paragraph:
[0034] FIG. 5 is a graph indicating an example of a predetermined relationship between an operating amount A.sub.cc of an accelerator pedal and an opening angle .theta..sub.TH of a throttle valve, which relationship is used by an electronic control device of the control system shown in FIG. 3, to control the throttle valve;

Detail Description Paragraph:
[0047] Referring to the block diagram of FIG. 3, there is shown a control system incorporating a vehicle control apparatus constructed according to one embodiment of this invention for controlling the engine 10, automatic transmission 14, etc. of the vehicle drive system shown in FIG. 1. The control system includes an electronic control device 90 which constitutes a major portion of the vehicle control apparatus of the invention. The electronic control device 90 receives an output signal of an accelerator sensor 51, which represents an operating amount A.sub.CC of a manually operable vehicle accelerating member in the form of an accelerator pedal 50. The operating amount A.sub.CC represents an output of the engine 10 as required by a vehicle operator, that is, a required amount of output of the engine 10 or a required vehicle drive force to drive the vehicle. An electronic throttle valve 56 is disposed in an intake pipe of the engine 10. The electronic throttle valve 56 is operated by a throttle actuator 54, which is controlled by the electronic control device 90 such that an opening angle .theta..sub.TH of the throttle valve 56 corresponds to the operating amount A.sub.CC of the accelerator pedal 50. A by-pass passage 52 is connected to the intake pipe, so as to by-pass the electronic throttle valve 56, and is provided with an ISC valve (idling speed control valve) 53, which functions to control an intake air quantity introduced into the engine 10 when the electronic throttle valve 56 is placed in its idling position. Namely, the ISC valve 53 is capable of controlling an idling speed

NE.sub.IDL of the engine 10. The ISC valve 53 is controlled by the electronic control device 90. The electronic control device 90 receives output signals of various sensors and switches, which include the above-indicated accelerator sensor 51 for detecting the operating amount A.sub.CC of the accelerator pedal 50, and further include the following sensors and switch: an engine speed sensor 58 for detecting an operating speed NE of the engine 10; an intake air quantity sensor 60 for detecting an intake air quantity Q introduced into the engine 10; an intake air temperature sensor 62 for detecting a temperature T.sub.A of the intake air; a throttle opening sensor 64 for detecting the opening angle .theta..sub.TH of the electronic throttle valve 56; a vehicle speed sensor 66 for detecting a rotating speed N.sub.OUT of the counter shaft 44, which is used to calculate a running speed V of the vehicle; a water temperature sensor 68 for detecting a temperature T.sub.W of a cooling water of the engine 10; a brake switch 70 for detecting an operating state BK of a braking system (not shown); a shift position sensor 74 for detecting a presently selected position P.sub.SH of the shift lever 72; a turbine speed sensor 76 for detecting a rotating speed NT of the turbine impeller 24, which is equal to a rotating speed N.sub.IN of the input shaft 22; a transmission temperature sensor 78 for detecting a temperature T.sub.OIL of a working fluid in the hydraulic control circuit 98; and a counter shaft speed sensor 80 for detecting a rotating speed NC of the first counter gear G1. The throttle opening sensor 64 is provided with an idling detector switch for detecting that the throttle valve 56 is placed in its idling position. The electronic control device 90 is connected to a data storage device 82 which includes a learning compensation value data map 112 and a reference compensation value data map 114, which will be described.

Detail Description Paragraph:
[0076] The control routine of FIG. 10 is initiated with step Q1-1 corresponding to the substantial synchronization determining means, to determine whether the input speed of the automatic transmission 14 has been increased to a threshold value close to the synchronization speed NTDWN. This determination is effected by determining whether a speed difference (NTDWN-NT) has become smaller than a predetermined threshold value. This threshold value may be a predetermined constant value, or may be determined on the basis of the specific kind of the shift-down action, and selected parameters such as the temperature T.sub.OIL, vehicle speed V and estimated input torque of the automatic transmission 14, and according to a predetermined data map or equation. If an affirmative decision (YES) is obtained in step Q1-1, the control flow goes to step Q1-2 to determine whether the ignition timing should be retarded or not. This determination is based on a calculated required amount TRQ1 of retarding of the ignition timing. If the calculated amount TRQ1 is zero, one cycle of execution of the routine is terminated. If the calculated amount TRQ1 is not zero, the control flow goes to step Q1-3 in which the igniter 94 is controlled to retard the ignition timing by the calculated required amount TRQ1, for thereby reducing the output of the engine 10. The required amount TRQ1 of retarding of the ignition timing is determined on the basis of selected parameters such as the vehicle speed V and estimated input torque of the automatic transmission 14. The required amount TRQ1 is zeroed when the vehicle speed V or the estimated input torque is lower or smaller than a predetermined threshold. In the example of FIG. 12, the ignition timing is retarded by the required amount TRQ1 at a point of time t3, when the affirmative decision (YES) is obtained in both of steps Q1-1 and Q1-2. As shown in FIG. 12, the ignition timing is held retarded for a predetermined time, and the amount of retarding is gradually reduced to zero.

CLAIMS:

1. An apparatus for controlling a drive system of an automotive vehicle including a manually operable vehicle accelerating member, a drive power source, and an automatic transmission having a plurality of forward drive positions which have respective different speed ratios and which are selectively established by respective combinations of engaging and releasing actions of a plurality of frictional coupling devices, said apparatus comprising feedback control means

operable upon a shift-down action of said automatic transmission which is effected by concurrent releasing and engaging actions of respective first and second frictional coupling devices of said plurality of frictional coupling devices, during an operation of said manually operable vehicle accelerating member to drive the automotive vehicle with said drive power source, said feedback control means feedback-controlling an engaging force of said first frictional coupling device, said apparatus further comprising: shifting-abnormality detecting means for detecting one of a racing of said drive power source and a tie-up behavior of said first and second frictional coupling devices during said shift-down action of said automatic transmission; and learning compensation means operable upon detection of said one of said racing and said tie-up behavior by said shifting-abnormality detecting means, for effecting learning compensation of an initial value of the engaging force of said first frictional coupling device at which a feedback control of said engaging force by said feedback control means is initiated.

7. An apparatus according to claim 6, wherein said pre-synchronization output reducing means retards said ignition timing on the basis of a running speed of the vehicle and an estimated input torque of said automatic transmission.

9. An apparatus according to claim 4, characterized by further comprising: shifting-abnormality detecting means for detecting one of a racing of said drive power source and a tie-up behavior of said first and second frictional coupling devices during said shift-down action of said automatic transmission; and learning compensation means operable upon detection of said one of said racing and said tie-up behavior by said shifting-abnormality detecting means, for effecting learning compensation of an initial value of the engaging force of said first frictional coupling device at which a feedback control of said engaging force by said feedback control means is initiated.

14. An apparatus according to claim 10, further comprising: tie-up detecting means for detecting a tie-up behavior of said first and second frictional coupling devices during said shift-down action of said automatic transmission; and learning compensation means operable upon detection of said racing by said racing-abnormality detecting means, or upon detection of said tie-up behavior by said tie-up detecting means, for effecting learning compensation of an initial value of the engaging force of said first frictional coupling device at which a feedback control of said engaging force by said feedback control means is initiated.